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Influence of Maternal Dietary Energy and Protein on the Embryonic Development of FUNAAB – Alpha Chickens

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ABSTRACT

The effects of varying maternal dietary energy and protein levels on the embryonic development of FUNAAB – alpha chickens were studied. Maternal diets were as follows: standard exotic layer diet (2600 Kcal/kg and 16%CP; Control), high energy low protein (2800Kcal/kg and 14%CP; HELP), high energy high protein (2800Kcal/kg and 18%CP; HEHP) and low energy high protein (2400Kcal/kg and 18%CP; LEHP). A total of 420 fertile eggs were collected and labelled according to maternal dietary treatments. Eggs (n=87) were broken out on days 6, 10, 15, 18 and 19 of incubation to ascertain the level of embryonic development. Embryo weight, length, percentage of weight change (PEWC) and relative embryonic weight (REW) were recorded for each embryo. A significant ($p<0.01$) influence of maternal diet on the embryonic weight was observed on all the days studied. The LEHP diet consistently maintained lower PEWC. The HEHP group supported better ($p<0.05$) relative embryonic weight (REW). By the 19th day, LEHP embryos were shorter ($p<0.001$) than those of the other groups. It was concluded that maternal dietary energy and protein levels influence the embryonic development of the FUNAAB – alpha chicken and that the diet of combinations control or HEHP maintain good developmental trajectory of embryos.

Keywords: Embryonic development, genetic, nutrition

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INTRODUCTION

Studies in broilers have demonstrated that maternal nutrition influences chick body weight (Van Emous, Kwakkel, van Krimpen, & Hendriks, 2015). The effects of maternal nutrition could directly be through incorporation of nutrients into the egg (Kenny & Kemp, 2007; Surai & Fisinin, 2012), or by triggering epigenetic modifications that regulate muscle progenitors (Saccone & Puri, 2010). The developing embryo is completely dependent for its growth and development on nutrients in the egg. Consequently, the physiological status of the chick at hatch (chick size, vigour and immune status) is greatly influenced by the nutrition of the hen.

Hatching egg composition varies with maternal nutrition, body composition, age, and strain (Nonis & Gous, 2013) which in turn also influence embryonic development and offspring performance. Moran (2007) stated that adequate deposition of protein in the egg by the hen is particularly important because towards the end of incubation it is highly used for gluconeogenesis by the embryo. Thus, nutritional deficiencies of the hen during egg formation may affect embryonic development. Kenny and Kemp (2007) reported that hens on low protein diets produced chicks with poor growth and higher mortality than those from hens on diets high in protein.

In Nigeria, efforts have been geared towards the development of indigenous chicken breeds with improved meat and egg production. These efforts have led to the development by the Federal University of Agriculture Abeokuta (FUNAAB) of the FUNAAB – alpha (Adebambo, 2015). However, there is little information on the influence of dietary protein and energy on the embryonic development of this strain. Therefore, the objective of this work was to evaluate the effects of varying levels of dietary energy and protein on the embryonic development of the FUNAAB – alpha Nigerian chicken.

MATERIALS AND METHODS

A total of 420 fertile eggs, 105 eggs for each treatment group from hens fed varying levels of dietary energy and protein were used for this experiment. The maternal diets were standard exotic breeder diet (2600 Kcal/kg and 16%CP; Control), high energy-low protein (2800 Kcal/kg and 14%CP; HELP), high energy-high protein (2800 Kcal/kg and 18%CP; HEHP) and low energy-high protein (2400 Kcal/kg and 18%CP; LEHP). The standard diet was based on the recommendation of Olomu (2011) for exotic hens in the tropics. The management of the hens is as described by Saleh, Mbap, Kalla, Doma, and Duwa (2017) while the dietary formula is shown in Table 1. The eggs were collected and labelled according to maternal dietary treatments. There were 21 eggs from each group which were broken out on days 6, 10, 15, 18 and 19 of incubation andit's the embryo was carefully removed and separated from all attachments such as chorioallantoic membrane and sac. The embryo was then wiped with an absorbent paper before weighing (Tona et al., 2010).

Table 1
Ingredients and percentage composition of different energy and protein diets fed to breeder chickens

Ingredients	CONTROL	HELP	HEHP	LEHP
Maize	56.83	68.34	58.31	45.33
Soya bean meal	20.61	16.28	28.55	24.95
Wheat bran	12.01	4.82	1.59	19.19
Vegetable oil	-	-	1.00	-
Bone meal	2.75	2.75	2.75	2.75
Limestone	7.00	7.00	7.00	7.00
Salt	0.35	0.35	0.35	0.35
Premix*	0.25	0.25	0.25	0.25
Methionine	0.10	0.10	0.10	0.10
Lysine	0.10	0.10	0.10	0.10
Total	100.00	100.00	100.00	100.00
Calculated Analysis				
ME (Kcal/Kg)	2600.00	2800.00	2800.00	2400.00
Crude Protein (%)	16.00	14.00	18.00	18.00
Calcium (%)	3.47	3.46	3.47	3.49
Phosphorus (%)	0.78	0.72	0.73	0.78

CONTROL – Standard Diet; HELP – High Energy Low Protein; HEHP – High Energy High Protein; LEHP – Low Energy High Protein
ME – Metabolizable energy
*Each 2.5kg HI-Mix® vitamin/mineral premix contain; Vitamin A – 10,000,000 I.U, Vitamin D3 – 2,000,000 I.U, Vitamin E – 12,000mg, Vitamin K3 – 2,000mg, Vitamin B1 – 1,500mg, Vitamin B2 – 4,000mg, Vitamin B6 – 1,500mg, Niacin – 15,000mg, Vitamin B12 – 10mcg, Pantothenic Acid – 5,000mg, Folic Acid – 500mg, Biotin – 20mcg, Choline Chloride – 100,000mg, Manganese – 75,000mg, Zinc – 50,000mg, Iron – 20,000mg, Copper – 5,000mg, Iodine – 1000mg, Selenium – 200mg, Cobalt – 5,000mg, Antioxidant – 125,000mg

All embryos were weighed to the nearest milligram using an electronic chemical balance (SF - 400). From day 15, the embryonic length was measured to the nearest millimetre with a ruler. The percentage of embryonic weight change (PEWC) and relative embryonic weight (REW) was calculated as follows:

$$\text{PEWC (\%)} = \frac{\text{Current weight (g)} - \text{Previous Weight(g)}}{\text{Previous Weight (g)}} \text{X } 100$$

$$\text{REW (\%)} = \frac{\text{Embryo weight (g)}}{\text{Egg weight (g)}} \text{X } 100$$

Statistical Analysis

Analysis of variance was carried out on all the data collected using the general linear model of SPSS 20.0 (2011). Where the mean scores differed, Duncan multiple range test was used to separate them (Duncan, 1955).

RESULTS

The effects of maternal dietary energy and protein on the embryonic weight, relative weight and length are shown in

Tables 2, 3 and 4 respectively. A significant ($p<0.01$) influence of maternal diet on the embryonic weight was observed for all the days studied. The HELP group had the lowest ($p<0.01$) weight. On day 10, HEHP and HELP had similar weights. Similarly, HELP did not differ from control and LEHP group. On day 15, LEHP had a significantly ($p<0.001$) lower weight than the other groups while by the 18th day, HEHP exhibited heavier embryonic weight. Day 19 revealed significantly ($p<0.001$) lighter embryos in the HELP and HEHP groups while weights of control and HEHP did not differ significantly. PEWC was significantly ($p<0.01$) influenced by maternal dietary treatment. The LEHP diet consistently maintained lower PEWC except on day 10, where it was similar ($p>0.05$) to the HEHP group. Relative embryonic weight was constantly higher in the HEHP group although it was not different ($p>0.05$) from the control group on days 6, 15 and 19 respectively.

Table 2
Effect of maternal dietary energy and protein on embryonic weight (g) and percentage weight change (in brackets) of Funaab - alpha chickens

Day	***Treatment***				
	CONTROL	*HELP*	*HEHP*	*LEHP*	*± SEM*
6	0.24^{a}	0.19^{b}	0.27^{a}	0.26^{a}	0.01*
10	1.86^{b} (834.60^{b})	1.91^{ab} (1090.20^{a})	2.06^{a} (807.50^{b})	1.86^{b} (819.70^{b})	0.05** (87.82**)
15	9.67^{a} (527.64^{a})	9.68^{a} (514.72^{a})	9.53^{a} (469.01^{ab})	7.92^{b} (429.82^{b})	0.33*** (29.82**)
18	16.52^{b} (181.69^{b})	16.48^{b} (171.37^{b})	18.69^{a} (201.88^{ab})	16.93^{b} (227.70^{a})	0.46** (16.57**)
19	21.79^{a} (134.94^{a})	20.13^{b} (124.36^{ab})	22.53^{a} (121.56^{b})	19.24^{b} (114.22^{b})	0.54*** (6.09**)

CONTROL - Standard Diet; HELP - High Energy Low Protein; HEHP - High Energy High Protein; LEHP - Low Energy High Protein
[a, b, c….] Means within the same row bearing different superscripts differ significantly ($p<0.05$); SEM: standard error of mean
NS: non significant ($p>0.05$); *: Significant ($p<0.05$); ** Significant ($p<0.01$); ***Significant ($p<0.001$)

Table 3
Effect of maternal dietary energy and protein on relative embryonic weight (%) of Funaab - alpha chickens

Day	***Treatment***				
	CONTROL	*HELP*	*HEHP*	*LEHP*	*± SEM*
Initial Egg Weight(g)	51.33	50.30	51.00	53.14	NA
6	0.47^{a}	0.39^{b}	0.53^{a}	0.52^{a}	0.04*
10	3.56^{b}	3.72^{b}	4.09^{a}	3.44^{b}	0.15*
15	18.68^{a}	18.63^{a}	18.85^{a}	14.60^{b}	0.82*
18	33.26^{b}	33.95^{b}	37.19^{a}	31.57^{b}	1.45*
19	42.71^{ab}	40.16^{b}	43.34^{a}	35.46^{b}	1.49*

CONTROL - Standard Diet; HELP - High Energy Low Protein; HEHP - High Energy High Protein; LEHP - Low Energy High Protein
[a, b, c….] Means within the same row bearing different superscripts differ significantly ($p<0.05$); SEM: standard error of mean; NS: Non significant ($p>0.05$); *: Significant ($p<0.05$); ** Significant ($p<0.01$); ***Significant ($p<0.001$); NA – Not analysed

Table 4
Effect of maternal dietary energy and protein on embryonic length (cm) of Funaab - alpha chickens

Day	***Treatment***				
	CONTROL	*HELP*	*HEHP*	*LEHP*	*±SEM*
15	9.93[a]	9.64[a]	9.33[a]	7.99[b]	0.26***
18	13.36	13.08	13.54	13.11	0.25[NS]
19	14.39[a]	14.11[a]	14.54[a]	12.96[b]	0.19***

CONTROL - Standard Diet; HELP - High Energy Low Protein; HEHP- High Energy High Protein; LEHP - Low Energy High Protein
[a, b, c….] Means within the same row bearing different superscripts differ significantly (p<0.05); SEM: standard error of mean; NS: non significant (p>0.05); *: Significant (p<0.05); ** Significant (p<0.01); ***Significant (p<0.001)

On day 15, the embryonic length was significantly (p<0.001) influenced by maternal diet with LEHP group being shorter than the others. There was no significant (p>0.05) difference among treatment means on day 18. However, by the 19th day, LEHP embryos were still shorter (p<0.001) than those of the other groups.

DISCUSSION

The LEHP combination resulted in consistently lower embryonic weight, weight gain, relative weight and length for most of the days, except on day 6 when HELP group had lower weight. Moraes (2013) reported that maternal dietary energy and protein had no effect on the embryonic weight of Ross 708 broiler chickens. The same author however reported that the group which was fed with high energy food during laying had longer embryos. Embryonic length measured across all the groups on day 18 in this experiment was shorter than the 17.88 to 18.45cm, as previously reported by Nangsuay, Ruangpanit, Meijerhof, and Attamangkune (2011) for broilers at different ages and 15.80 to 16.60 cm according to Moraes (2013) for broiler breeders fed with different energy and protein levels during rearing and laying periods. According to Nangsuay et al. (2011), embryonic length at development is closely related to chick length at hatch. Chick length in turn is positively correlated with the growth potential.

Overall, embryonic growth was the highest in all groups between days 6 to 15. This is similar to the observation of Egbeyale et al. (2013) who reported embryos of the Dominant black and Yaffa brown strains of chicken to have slower rate of development during the early days (days 1 to 10) of incubation but faster between days 10 and 18. Similarly, Oke, Obanla, Onagbesan and Daramola (2015) reported increased embryonic weight between day 7 and 11 for the Nigerian indigenous chicken and two layer strains (Isa Brown and Nera Black).

Embryonic weight and weight gain on days 15 and 18 as observed in this study are similar to those reported by Oke et al. (2015) for the Nigerian indigenous chicken. Relative embryonic weight for all the groups in this study were however, lower than those observed by Egbeyale et al. (2013) for the Dominant black and Yaffa brown strain of chicken. The observed difference may be related to the genetic difference between the strains used. Li, Zhao and Wu (2009), and Tona et al. (2010) reported an influence of breed (strain) on embryogenesis in chicken.

CONCLUSION

It is concluded that maternal dietary energy and protein levels influence embryonic development of the FUNAAB – alpha chicken and the standard or high energy high protein diets will maintain good developmental trajectory of embryos.

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